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Patentanmeldung Nr. Patent application No. Demande de brevet n°

03076992.1

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(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

An optical disk drive

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An optical disk drive

The invention relates in general to an optical disk drive, and more specifically to an optical disk drive comprising an electronic unit comprising a first electronic circuit; an optical pick-up unit, movably assembled with respect to the electronic unit, comprising light generation means for writing/reading data to/from an optical disk and comprising a second electronic circuit comprising a plurality of light sensors for receiving reflected light from the disk which originates from the light generation means, each light sensor having an output for delivering an electrical signal; and coupling means for coupling the second electronic circuit to the first electronic circuit for transferring information between the first and second electronic circuits.

The invention also relates to a play back/recording apparatus comprising an optical disk drive.

As is commonly known, an optical storage disk comprises at least one track, either in the form of a continuous spiral or in the form of multiple concentric circles, of storage space where information may be stored in the form of a data pattern. Optical disks may be read-only type, where information is recorded during manufacturing, which information can be read by a user. The optical storage disk may also be a writable type, where information may be stored by a user. For writing information in the storage space of a writable optical storage disk, an optical disk drive comprises, on the one hand, rotating means for receiving and rotating an optical disk, and on the other hand light generation means for generating an optical beam, typically a laser beam, and for scanning the storage track with said laser beam. Since the technology of optical disks in general, and the way in which information can be stored in an optical disk, is commonly known, it is not necessary here to describe this technology in great detail. For understanding the present invention, it is sufficient to mention that the laser beam is modulated such as to cause a pattern of locations where properties of the disk material have changed, such pattern corresponding to coded information. During recording an optical disk a laser driver controls the laser by a drive current. This drive current, and consequently the light emitted by the laser, follows a desired pattern determined by the coded information.

The optical disk drive comprises a lot of mechanics and electronics. The larger part of the electronics is placed in the electronic unit by the availability of a so called printed circuit board. The printed circuit board will be further denoted as PCB. The PCB is in one way or another fixed to a housing of the electronic unit. The optical pick-up unit which will be further denoted as OPU, is movably assembled with respect to the housing and thus also with respect to the PCB. The OPU comprises i.a. the laser, the plurality of light sensors which are usually implemented by light sensitive photo diodes, a lens system, and part of the electronics of the disk drive. The lens system ensures correct focusing of the laser light on the surface of the disk, whereas the photo diodes convert the reflected light into electrical signals. The OPU can move in horizontal direction by the availability of a so called swing arm, or more usually, a so called sledge. Also other means for moving the OPU can be applied. Further the laser and/or lens system can be moved in vertical direction for the focusing purpose. By the movability of the OPU the light emitted by the laser can be positioned in order to radiate light on desired positions of the disk. By using more than one photo diode it is not only possible to retrieve an HF-signal from the disk from which the data can be retrieved, but also to measure the deviation and hence to correct the position of the sledge (or other means) and to control the vertical movement of the laser or the lens system. Thus also tracking and focusing is performed with the information (the electrical currents) received from the photo diodes. The tracking is usually denoted as " push-pull" radial tracking. The push-pull tracking is generally known and well described in known literature. Therefore a detailed description of the principles of push-pull is not necessary. In respect to the present invention it suffices to mention that often use is made of the so called three-spots radial tracking push-pull system, which will be further denoted as "3-spots push pull". The 3-spots push pull is also well known from literature. By using the 3-spots push pull, three spots are generated by the addition of a spatial grating in the light path created by the laser. Also three spots are reflected back to the photo diodes. So usually three segments of photo diodes are used for getting accurate tracking. Normally each segment comprises several photo diodes. In many occasions eight separate electrical currents are delivered by the photo diodes. These currents are transferred to the electronics on the PCB for further processing. Since these currents are quite weak, they are usually first amplified before being transferred to the PCB via the coupling means. In this way these electrical currents are less disturbed by unwanted signals generated somewhere in the electronics which are picked-up by the coupling means. Thus by first amplifying the weak electrical signals, a higher signal-to-noise ratio can be achieved. This results in a more reliable control of e.g. the push-pull tracking.

Since the OPU is movable with respect to the PCB, the coupling means can not be made of mechanical stiff electrical connections. So special coupling means must be applied. Therefore these coupling means are not very cheap. Therefore there is a tendency to try to minimize the number of electrical wires within the coupling means.

It is therefore an object of the invention to reduce the number of electrical connections between the OPU and the PCB.

To achieve the object of the invention the optical disk drive as defined in the opening paragraph is characterized in that during a normal operation mode a number of the electrical signals is combined by the second electronic circuit, these combined electrical signals and the remaining uncombined electrical signals being transferred via the coupling means to the first electronic circuit, and that during a test mode all or part of the electrical signals are separately processed by the second electronic circuit.

In the known optical disk drive all electrical signals from the second electronic circuit, which is part of the OPU, are transferred via the coupling means to the first electronic circuit, which is part of the PCB, because during a test mode all these electrical signals are needed separately by a so called test circuit within the first electronic circuit. The test circuit is only active during test mode which is only used during the manufacturing of the optical disk drive. During test mode a position (including angles) of the photodiodes with respect to the reflected light from a disk, is defined (calibration). So during normal use by the users, this test mode will never be used again.

The invention is based on the insight that with respect to the retrieving of the HF signal, the tracking and the focus control, not all electrical signals are needed since some of them are summed in the first electronic circuit. Thus by moving the test circuit from the first electronic circuit on the PCB to the second electronic circuit on the OPU it is then possible to make the summation already in the second electronic circuit, so that less number of electrical signals have to be transferred via the coupling means to the PCB. The test circuit can very easily be implemented in the second electronic circuit. This is because it is usually implemented in an integrated circuit. Therefore it does not have the disadvantage of a significantly increase of weight of the OPU. An increase in weight could be disadvantageous with respect to the mechanical construction of the OPU and with respect to the power consumption of the OPU. So only during test mode all electrical signals need separate amplification by the amplifiers. The invention has the additional advantage that during normal mode, in which some electrical currents from the photo diodes are combined (summed), part of the amplifiers can be switched off. This results in a lower power

consumption by the amplifiers. So for instance only 6 of total 8 electrical currents are transferred via the coupling means, and 2 of total 8 amplifiers are switched off during the normal mode.

As defined in claim 2, the coupling means are preferably implemented by a flexible electrical connection device. This is because of the fact that the OPU must be movable with respect to the PCB.

As defined in claim 3, the flexible electrical connection device may be a flexible printed circuit.

An embodiment of the optical disk drive is characterized in that during operation the light generation means generates a main light spot and first and second satellite light spots, and that the plurality of light sensors is divided in a main part for receiving light which originates from the main light spot, a first satellite part for receiving light which originates from the first satellite light spot, and a second satellite part for receiving light which originates from the second satellite light spot, and that the combined electrical signals are combinations of electrical signals corresponding to the first and the second satellite parts of the light sensors.

By doing so, the so called 3-spot push pull system is used. Since some of the electrical currents corresponding to the satellite light spots can be summed during the normal mode, the number of electrical currents to be transferred via the coupling means is reduced. The summation can be accomplished by activating switches which short-circuit an input of an amplifier with an input of another amplifier.

An embodiment of the optical disk drive is characterized in that the second electronic circuit comprises a BUS-system for controlling the gain or gains of at least one of the amplifiers by at least one control bit of the BUS-system, and that additional information can be sent via the BUS-system for switching off or setting standby part of the amplifiers by the fact that the amplitude of the at least one control bit (which may be a voltage or a current) can be made larger than necessary for controlling the gain or gains of at least one of the amplifiers. Via the BUS-system the gain of each amplifier can be set independently of each other. This is advantageous because the first electronic circuit on the PCB may need to process the electrical currents with different gain values. This can for instance be caused by the fact that the electrical currents corresponding to the satellite light spots are usually much weaker than the electrical currents corresponding to the main light spot. The sending of the additional information via the BUS-system for switching off or setting standby part of the

amplifiers in the abovementioned manner is advantageous because otherwise the number of control bits used for the BUS-system would have been larger.

An embodiment of the optical disk drive is characterized in that the BUS-system uses a three level logic. Usually a binary level logic is applied for a BUS-system. By applying a three level logic a fewer number of control bits is necessary. In this embodiment the sending of the additional information via the BUS-system for switching off or setting standby part of the amplifiers, as mentioned in the previous embodiment, can still be accomplished by the fact that the amplitude of the at least one control bit can be made larger than necessary for controlling the gain or gains of at least one of the amplifiers. Alternatively, as defined in claim 8, the additional information is sent via the BUS-system without making the amplitude of the at least one control bit larger than usually. This is because with a three level logic more information can be sent per electrical connection of the BUS-system, compared to a binary level logic.

An embodiment of the optical disk drive is characterized in that at least one power supply line of the at least one amplifier is also used for sending the additional information by temporarily increasing or decreasing the voltage level on the at least one power supply line. By using the so-called V_{DD} or V_{SS} power line of an amplifier for switching off or setting standby part of the amplifiers the number of electrical wires of the BUS-system might be smaller, especially in the situation where a binary level logic is applied. For example the lowering of the voltage at the V_{SS} power line of an amplifier can only be temporarily because otherwise the corresponding amplifier can not perform its normal amplifying task when needed. The V_{SS} power line may for example be a common V_{SS} power line for all the amplifiers. Alternatively, the same can be accomplished by a V_{DD} power line. In the latter case the voltage on the V_{DD} power line should be temporarily increased. Because of the fact that the voltage on a power line of an amplifier may only be decreased or increased temporarily, the corresponding amplifiers (the ones needed for the test mode) must be provided with some kind of memory means, e.g. a latch.

The invention will be described in more detail with reference to the accompanying drawings, in which:

Figure 1 shows a schematic drawing of an OPU;

Figure 2 shows part of tracks radiated by a main spot and two satellites spots;

Figure 3 shows light sensitive photo diodes for generating electrical currents in order to retrieve the HF-signal, focus control, and 3-spot push pull tracking control;

Figure 4 shows part of an optical disk drive; and

Figure 5 shows an embodiment of the invention.

In these figures parts or elements having like functions or purposes bear the same reference symbols.

Figure 1 shows an example of a schematic drawing of an OPU. The OPU comprises a laser LS, a spatial grating GRT, a polarized beam splitter PBS, a collimator (lens) CLM, a 1/4 λ plate PLT, an objective lens OL, and light sensitive photo diodes PHDS. Further an optical disk DSK is shown.

The laser generates a very small light beam L which passes through the grating GRT to form three light beams 3L. The three light beams 3L are necessary in the situation where a so-called 3-spot push pull tracking control is desired. (Otherwise the grating GRT can be left out.) The three light beams 3L are mirrored towards the collimator CLM by the polarized beam splitter PBS. The diverging light beams which come out of the collimator CLM is changed into parallel (that is to say non-diverging and non-converging) light beams. The parallel light beams passes the 1/4 λ plate PLT to shift the polarization of the light beams with approximately 90 degrees. The objective lens OL converge the light beams on the desired positions of the optical disk DSK which is for instance a DVD. (Depending on the design, it is sometimes possible to leave out the collimator CLM by choosing a higher diopter value for the objective lens OL.)

Light reflected from the disk DSK, which is now modulated by the information on the disk DSK, passes the 1/4 λ plate PLT to shift the polarization of the light with approximately 90 degrees. It is then passed through the collimator CLM. Because the polarization of the reflected light is now opposite (shifted with 180 degrees) compared to the "incoming" light beams from the laser LS, it is not mirrored back towards the laser LS by the polarized beam splitter PBS, but it passes the polarized beam splitter PBS. Thus reflected light, indicated by RFL, is focused on the light sensitive photo diodes PHDS. The photo diodes PHDS respond to this light by generating electrical currents which comprises the data read from the disk DSK, which can be retrieved after de-modulating the HF-signal(s) delivered by the photo diodes PHDS, and which comprises information needed for focus control and for (3-spot) push pull tracking control.

Figure 2 shows part of tracks radiated by a main light spot and two satellites light spots. On track TR the main light spot MSP is focused, while a first satellite light spot FST falls in between a left track LTR and the track TR, and a second satellite light spot SST falls in between the track TR and a right track RTR. In the indicated situation there is ideal push pull tracking and the reflected light RFL (see figure 1) falls on the photo diodes PHDS in the way as indicated in figure 3. (This is under the assumption that during manufacturing process the position/angles of the photo diodes are calibrated during a so called test mode phase.) Temporarily the spots MSP, FST, and SST can be shifted e.g. towards the left. Then however, a main part A-B of the photo diodes PHDS which receives light corresponding to the main light spot MSP will also shift, and consequently the electrical signals I_A - I_B will change. The same holds for the first E,F and second G,H satellite parts of the photo diodes PHDS which receive light corresponding to the first FST and the second SST satellite light spots, respectively. As a response on the changes in the electrical signals I_A - I_H, a push pull tracking control (often also called servo control) changes the horizontal position of the laser beams focused on the disk DSK by e.g. a so called sledge (not shown in figure 1) on which the OPU is mounted. Also focus control and the retrieving of the code information can be derived from the electrical currents I_A - I_H. Since the retrieving of the data, the focus control, and the push pull control are well known techniques more detailed explanation for these techniques is not necessary.

Figure 4 shows part of an optical disk drive. The optical disk drive comprises i.a. a PCB which comprises the larger part of the electronics. Part of these electronics is indicated by a first electronic circuit CRT_1. The optical disk drive further comprises an OPU which comprises several mechanical components (not indicated in figure 4) and some electronics indicated by a second electronic circuit CRT_2. The second electronic circuit CRT_2 comprises the photo diodes PHDS (see also figure 3) for receiving the reflected light RFL (see also figure 1). The photo diodes PHDS deliver the electrical currents (see I_A-I_H in figure 3). In the known disk drives all these electrical currents are transferred via a flexible electrical connection device FCD to the first electronic circuit CRT_1. The first electronic circuit CRT_1 processes the electrical currents. Some currents are summed. In fact this summation could already have been accomplished in the second electronic circuit CRT_2 so that fewer number of electrical wires are needed in the flexible electrical connection device FCD. Up to now this is not done because all electrical currents are separately needed during a test mode which is performed by a test circuit TST within the first electronic circuit.

In the inventive embodiment as shown in figure 5 the test circuit TST is part of the second electronic circuit CRT_2 (and thus part of the OPU in stead of the PCB) in stead of the first electronic circuit CRT_1. The test circuit TST is only active during test mode which is only used during the manufacturing of the optical disk drive. During test mode a position (including angles) of the photodiodes PHDS with respect to the reflected light from a disk DSK, is defined (calibration). During test mode the switches S_1 and S_2 are open (as indicated in figure 5). As a consequence all the electrical currents I_A - I_H are separately amplified by the amplifiers AMP_A - AMP_H, and all output currents from the amplifiers AMP_A - AMP_H are separately coupled to the test circuit TST.

In the normal (user) mode the test circuit TST is always inactive and the switches S_1 and S_2 are closed. Further also amplifiers AMP_E and AMP_H are made inactive. This can be controlled via the bus-system BUS. By the closure of the switch S_1 the electrical current I_E, which can no longer be amplified by the amplifier AMP_E, is added to the electrical current I_G, so that the sum of these two currents is amplified by the amplifier AMP_G. By the closure of the switch S_2 the electrical current I_H, which can no longer be amplified by the amplifier AMP_H, is added to the electrical current I_F, so that the sum of these two currents is amplified by the amplifier AMP_F. The outputs of the amplifiers except for the amplifiers AMP_E and AMP_H are coupled to the flexible electrical connection device FCD. So, in this example, only six electrical currents are transferred via the flexible electrical connection device FCD in stead of eight in the known optical disc drives.

The bus-system BUS deliver control bits for setting the gains of the amplifiers AMP_A-AMP_H. These gains can be set individually. Via an extra control bit the amplifiers AMP_E and AMP_H can be switched off during the normal mode. This saves power consumption. Instead of using the extra control bit it is also possible to temporarily increase/decrease the voltage/current of a control bit (used for setting a gain) above/below a normal voltage/current value to indicate that the amplifiers AMP_E and AMP_H should be switched off. Instead of using a control bit it is also possible to e.g. temporarily decrease the voltage level at the V_{SS} power line of the opamps AMP_A-AMP_H.

Alternatively the BUS-system BUS can use three level logic control bits so that more information per control bit is available. Then both gain setting signals and switching off signals for the opamps AMP_A-AMP_H can be delivered via the BUS-system without extension of the number of control bits.

CLAIMS:

1. An optical disk drive comprising an electronic unit (PCB) comprising a first electronic circuit (CRT_1); an optical pick-up unit (OPU), movably assembled with respect to the electronic unit (PCB), comprising light generation means (LS) for writing/reading data to/from an optical disk (DSK) and comprising a second electronic circuit (CRT_2) comprising a plurality of light sensors (PHDS) for receiving reflected light (RFL) from the disk (DSK) which originates from the light generation means (LS), each light sensor having an output for delivering an electrical signal (I_A - I_H); and coupling means for coupling the second electronic circuit (CRT_2) to the first electronic circuit (CRT_1) for transferring information between the first (CRT_1) and second (CRT_2) electronic circuits, characterized in that during a normal operation mode a number of the electrical signals (I_E,I_G; I_F,I_H) is combined by the second electronic circuit (CRT_2), these combined electrical signals (I_E,I_G; I_F,I_H) and the remaining uncombined electrical signals (I_A -I_D) being transferred via the coupling means to the first electronic circuit (CRT_1), and that during a test mode all or part of the electrical signals are separately processed by the second electronic circuit (CRT_2).

2. An optical disk drive according to claim 1, characterized in that the second electronic circuit (CRT_2) comprises a plurality of amplifiers (AMP_A - AMP_H) each having an input separately coupled to the outputs of the light sensors during the test mode, and each having an output, a number of the outputs of the amplifiers which number equals the number of the combined and the remaining uncombined electrical signals during the normal operation mode, is separately coupled to the coupling means; and that a number of the inputs of the amplifiers which number equals the number of the combined electrical signals, is separately coupled to other inputs of the amplifiers during the normal operation mode.

3. An optical disk drive according to claim 1 or 2, characterized in that the coupling means are implemented by a flexible electrical connection device (FCD).

4. An optical disk drive according to claim 3, characterized in that the flexible electrical connection device (FCD) is a flexible printed circuit.

5. An optical disk drive according to any of the preceding claims, characterized in that during operation the light generation means (LS) generates a main light spot (MSP) and first (FST) and second (SST) satellite light spots, and that the plurality of light sensors (PHDS) is divided in a main part for receiving light which originates from the main light spot, a first satellite part for receiving light which originates from the first satellite light spot, and a second satellite part for receiving light which originates from the second satellite light spot, and that the combined electrical signals (I_E,I_G; I_F,I_H) are combinations of electrical signals corresponding to the first and the second satellite parts of the light sensors.

6. An optical disk drive according to claim 5, characterized in that the main part comprises four sections (A, B, C, D) for delivering four of the electrical signals, further to be denoted as the four main electrical signals (I_A, I_B, I_C, I_D), the first satellite part comprises two sections (E, F) for delivering two of the electrical signals not being the four main electrical signals (I_A, I_B, I_C, I_D), further to be denoted as the two first satellite part electrical signals (I_E, I_F), and the second satellite part comprises two sections (G, H) for delivering two of the electrical signals not being the four main electrical signals (I_A, I_B, I_C, I_D) or the two first satellite part electrical signals (I_E, I_F), further to be denoted as the two second satellite part electrical signals (I_G, I_H), and that during the normal operation mode at least one of the two first satellite part electrical signals (I_E, I_F) is combined with at least one of the two second satellite part electrical signals (I_G, I_H).

7. An optical disk drive according to claim 2, 3, 4, 5, or 6, characterized in that the second electronic circuit (CRT_2) comprises a BUS-system (BUS) for controlling the gain or gains of at least one of the amplifiers (AMP_A - AMP_H) by at least one control bit of the BUS-system (BUS), and that additional information can be sent via the BUS-system (BUS) for switching off or setting standby part of the amplifiers by the fact that the amplitude of the at least one control bit can be made larger than necessary for controlling the gain or gains of at least one of the amplifiers.

8. An optical disk drive according to claim 7, characterized in that the BUS-system (BUS) uses a three level logic.

9. An optical disk drive according to claim 2, 3, 4, 5, or 6, characterized in that the second electronic circuit (CRT_2) comprises a three level logic BUS-system (BUS) for controlling the gain or gains of at least one of the amplifiers (AMP_A - AMP_D) by at least one control bit of the BUS-system (BUS), and for sending additional information via the BUS-system (BUS) for switching off or setting standby part of the amplifiers.

10. An optical disk drive according to claim 7, 8, or 9, characterized in that at least one power supply line (V_{SS}) of the at least one amplifier (AMP_A - AMP_D) is also used for sending the additional information by temporarily increasing or decreasing the voltage level on the at least one power supply line (V_{SS}).

11. A play back/recording apparatus comprising an optical disk drive as defined in any of the preceding claims.

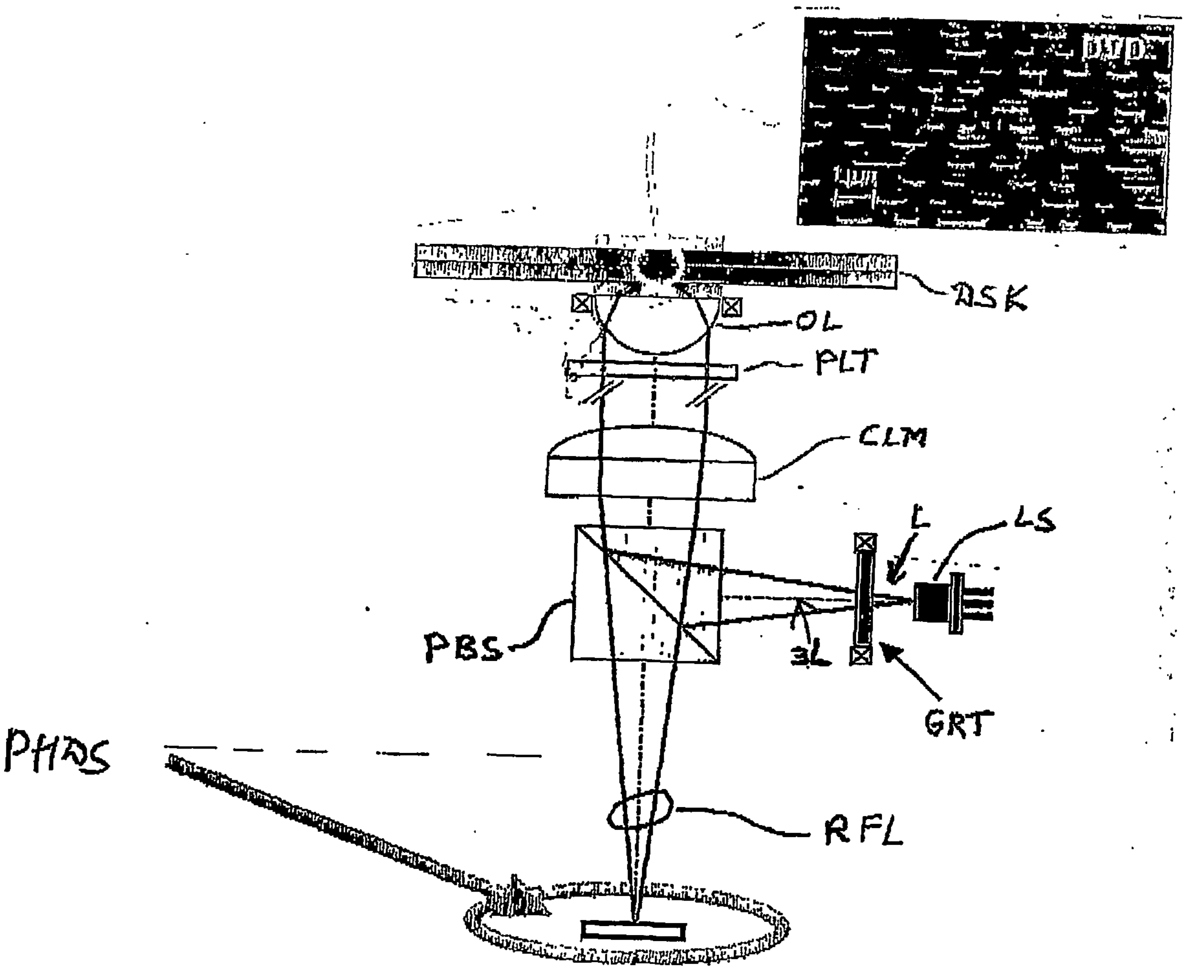
ABSTRACT:

An optical disk drive comprising an electronic unit (PCB) comprising a first electronic circuit (CRT_1); an optical pick-up unit (OPU), movably assembled with respect to the electronic unit (PCB), comprising light generation means (LS) for writing/reading data to/from an optical disk (DSK) and comprising a second electronic circuit (CRT_2) comprising a plurality of light sensors (PHDS) for receiving reflected light (RFL) from the disk (DSK) which originates from the light generation means (LS), each light sensor having an output for delivering an electrical signal (I_A - I_H); and coupling means for coupling the second electronic circuit (CRT_2) to the first electronic circuit (CRT_1) for transferring information between the first (CRT_1) and second (CRT_2) electronic circuits.

During a normal operation mode a number of the electrical signals (I_B,I_G; I_F,I_H) is combined by the second electronic circuit (CRT_2), these combined electrical signals (I_B,I_G; I_F,I_H) and the remaining uncombined electrical signals (I_A -I_D) are transferred via the coupling means to the first electronic circuit (CRT_1).

During a test mode all or part of the electrical signals are separately processed by the second electronic circuit (CRT_2).

Fig. 5



OPU

Fig. 1

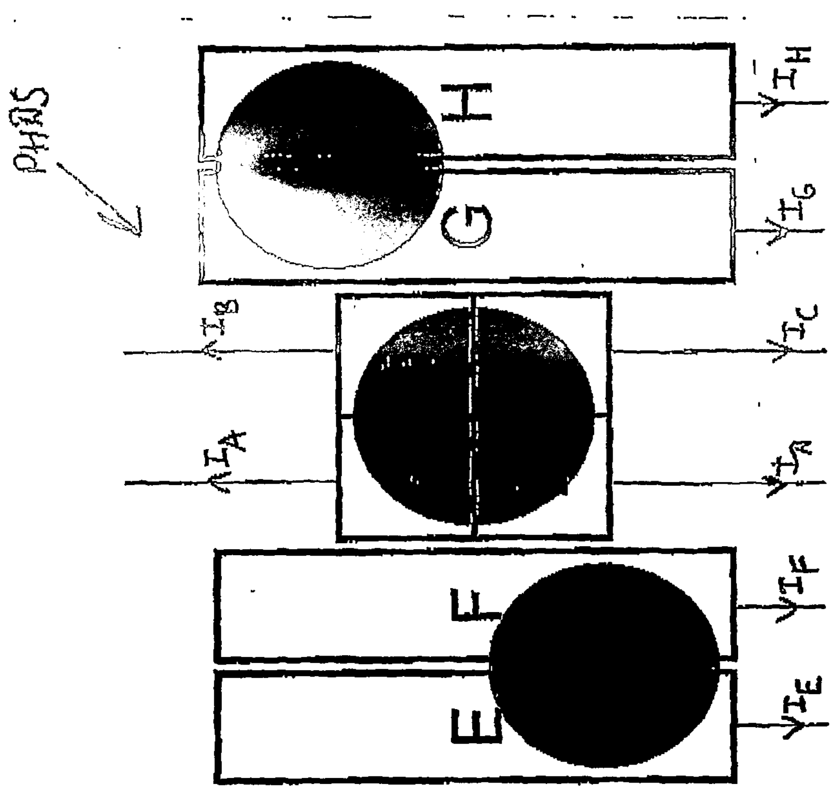


Fig. 3

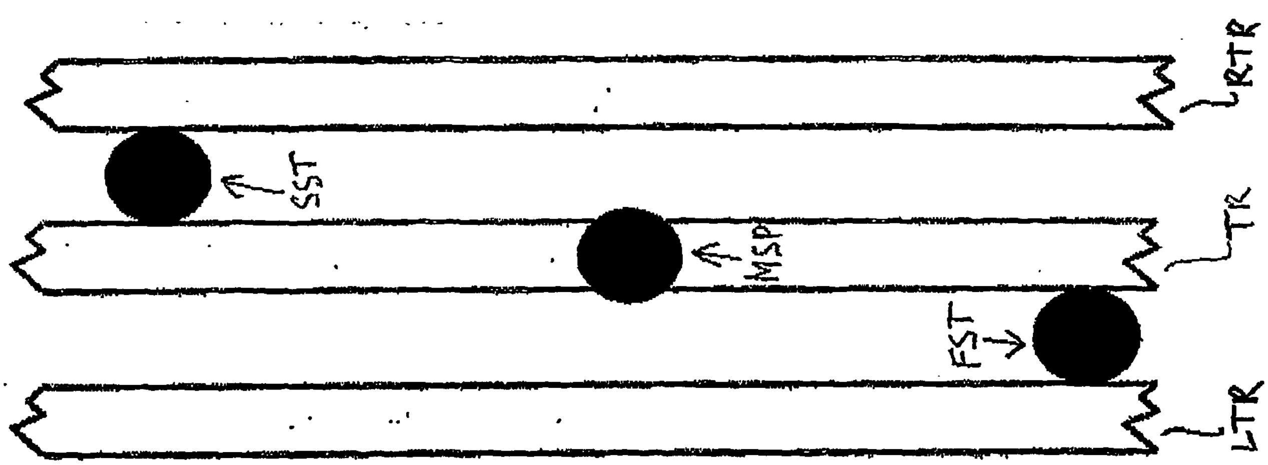


Fig. 2

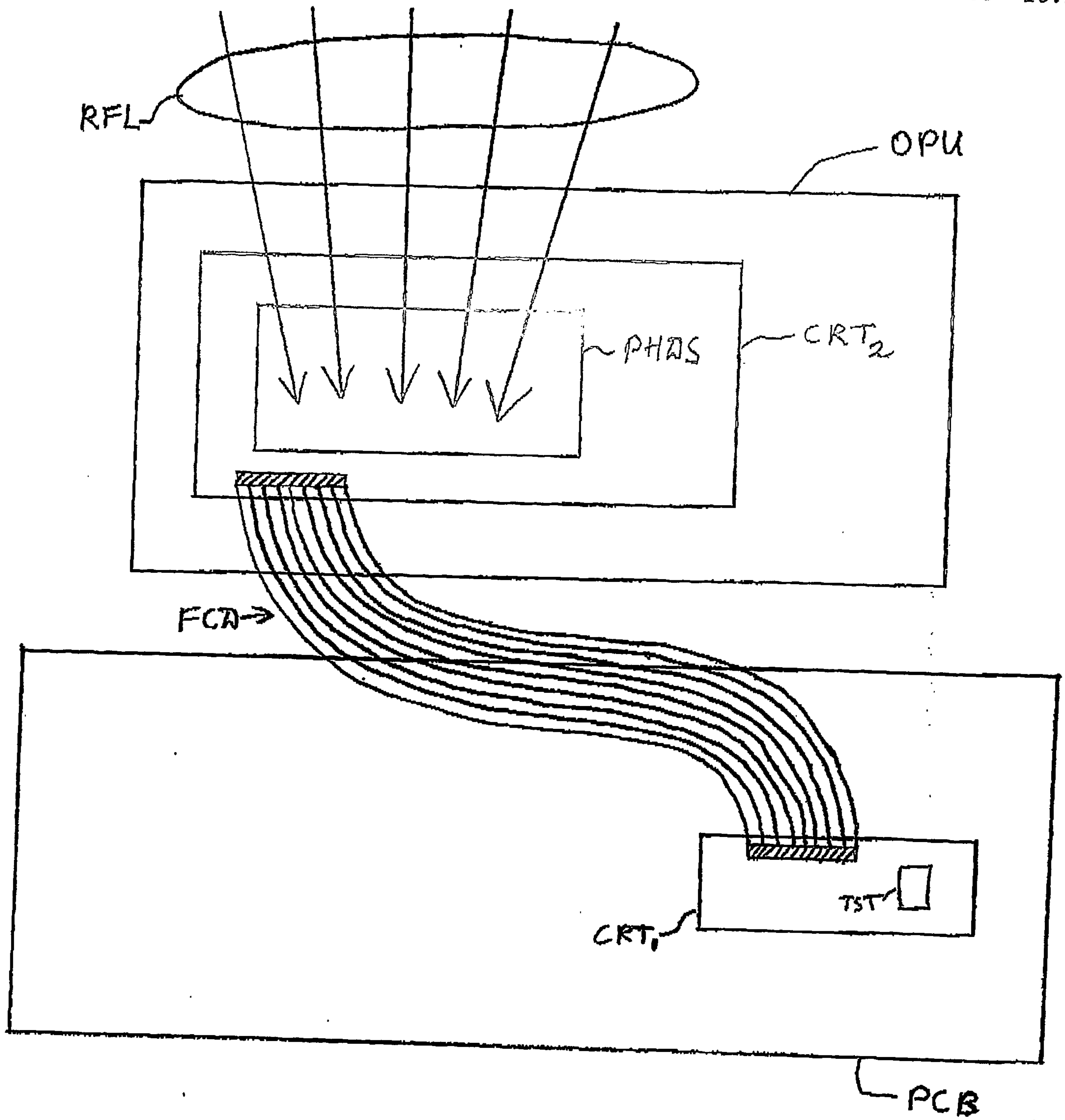


Fig. 4

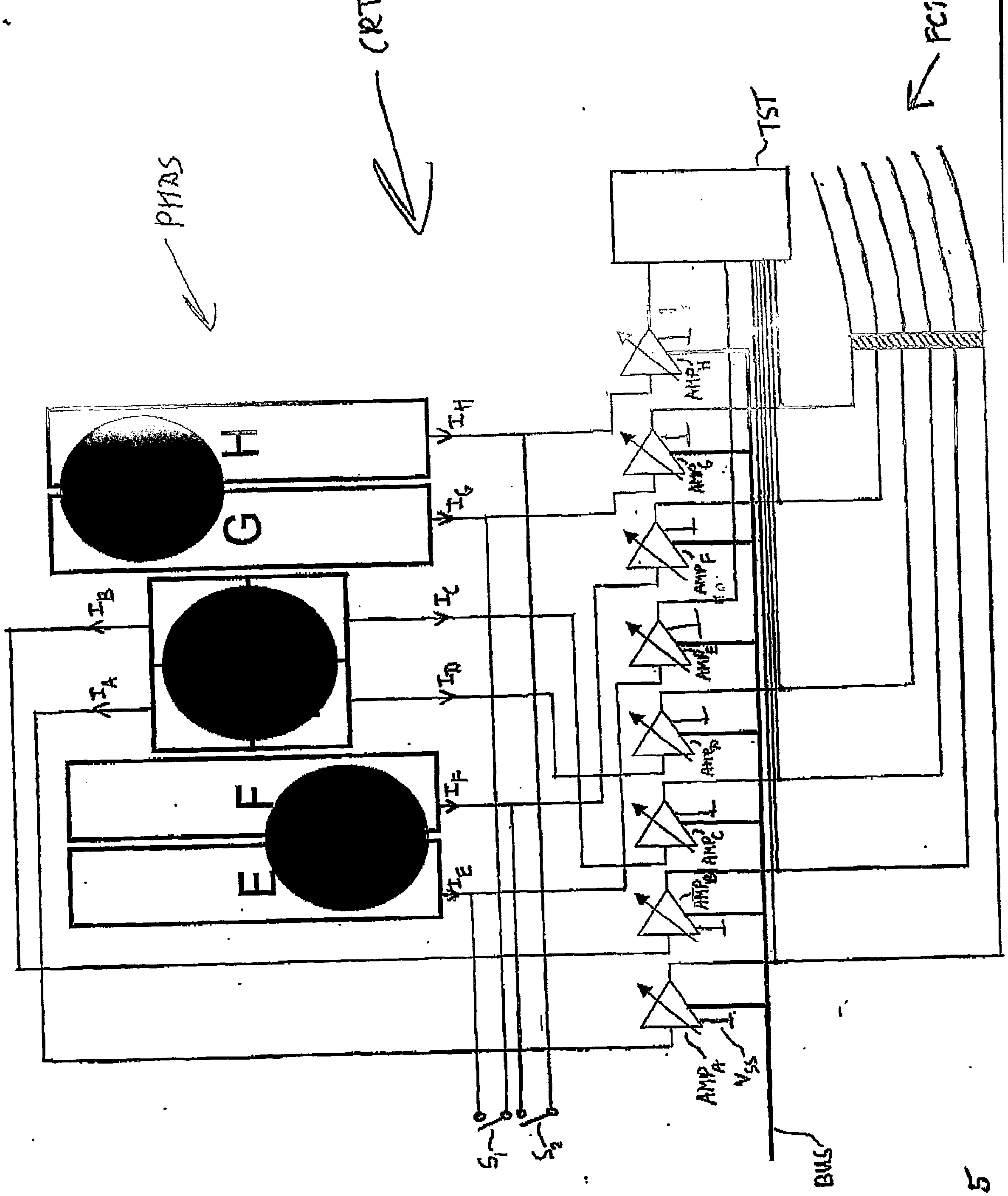

PHAS
CRT
FCT
TST
H
G
E
F
I_H
I_G
I_C
I_D
I_F
I_E
I_B
I_A
AMP_A
AMP_B
AMP_C
AMP_D
AMP_E
AMP_F
AMP_G
AMP_H
V_{SS}
S_1
S_2
BUS

Fig. 5

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